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Method and apparatus for automatically scrubbing a surface.

The apparatus disclosed removes oxide from the contact pads of the wafer under test. The apparatus has a test probe membrane (1-13) attached to a traveling device (1-3). The traveling device (1-3) attaches to a base (1-5) through one or more constant length pivoting devices (1-7) and one or more variable length springs (1-9). When a wafer pushes against the test probe membrane (1-13), the traveling device (1-3) moves upwards. The constant length pivotal device (1-7) and the variable length springs (1-9) control the sideways motion of the traveling device (1-3). When the traveling device (1-3) lifts from its resting position, it moves sideways and thereby allows the test probe membrane (1-13) to scrub the contact pads of the wafer under test.

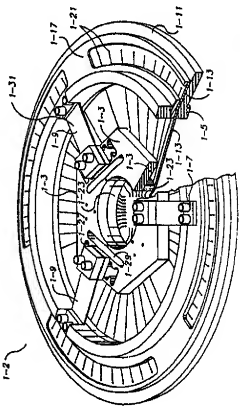

FIG 1

EP 0 283 219 A2

METHOD AND APPARATUS FOR AUTOMATICALLY SCRUBBING A SURFACE

FIELD OF THE INVENTION

The invention relates to the field of automatic surface scrubbers.

BACKGROUND OF THE INVENTION

In order to conduct tests on the electronic components of a wafer, a test probe must form a low impedance connection with the wafer. Often, silicon wafers have contact pads coated with aluminum. This aluminum coating readily oxidizes into a non-conductive film 5 - 10 nm thick. When a test probe contacts this surface, the oxide film insulates the wafer from the test probe. In order to make a low impedance connection, the test probe must scrub the wafer's contact pads.

Wafer test probes commonly have numerous wires that dig into contact pads of the wafer under test. The digging ploughs oxide off the contact pads and permits a low impedance connection. If a test probe uses contact pads instead of wires, as described in EP 0230348 entitled Test Probe incorporated herein by reference, the oxide remains on the wafer's contact pads and prevents the test probe from making a low impedance connection with the wafer. In order to perform the high frequency testing that modern day wafers require, the test probe must form a low impedance connection with the wafer. If the test probe cannot make a low impedance connection with the wafer, the high frequency tests must be delayed until the wafer is diced and packaged as chips. At this point, the loss is greater if a packaged chip must be discarded since the investment is greater.

SUMMARY OF THE INVENTION

The apparatus, according to the preferred embodiment of the present invention, removes oxide from the wafer contact pads. The apparatus forces the test probe pads to move sideways on the wafer contact pads when the test probe is forced against the wafer. This motion, known as scrubbing, breaks the oxide layer covering the wafer contact pads and exposes the fresh underlying metal. With the exposure to the fresh underlying metal, the test probe makes a low impedance connection with the wafer under test.

The apparatus according to the present invention has one or more constant length pivot devices and one or more variable length springs connected between a base and a traveling device. When the traveling device moves away from the base, the constant length pivot device rotates about the base and pulls on the traveling device and the variable length spring. In response to the pulling force of the constant length pivot device, the variable length spring expands to accommodate the sideways motion of the traveling device. The traveling device's sideways motion towards the constant length pivot device produces scrubbing. A test probe, as described in U.S. Patent Application 816,666 referenced above, connected to the traveling device scrubs the wafer contact pads.

The constant length pivot device is a leaf spring or a device equivalent to a leaf spring. The variable length spring has a leaf spring or a device equivalent to a leaf spring and expansion device that lengthens in the sideways direction. The expansion device can be an integral part of the traveling device and can have holes that expand in the direction of motion.

The present invention has the advantage of producing a controlled scrub of a wafer or other device. By controlling the parameters of the constant length pivot device and the variable length spring, one controls the scrub motion. When the present invention is used to scrub the contact pads of wafers, it has the additional advantage that all contact pads receive the same scrub motion.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows the preferred embodiment of the invention.

Figure 2 shows a top view of the apparatus shown in Figure 1.

Figure 3 shows a cross section A-A designated in Figure 2.

Figure 4 shows an alternate embodiment of the variable length spring.

DETAILED DESCRIPTION OF THE INVENTION

The items have been given a two-part number with a dash separating the parts. The number to the left of the dash refers to the figure number and the number to the right of the dash refers to the part number. Part numbers will remain unchanged from drawing to drawing.

Figure 1 shows an apparatus according to the preferred embodiment of the invention. The cut away portion 1-1 shows a cross section of the apparatus. The travelling device 1-3 is connected

to a base 1-5 through the constant length pivot device 1-7 and two variable length devices 1-9 located 120° apart. Alternate embodiments of the invention may use more than one constant length pivot device 1-7 and one or more variable length devices 1-9. In the preferred embodiment the invention, the base 1-5 has a base ring 1-15 attached to a base plate 1-11. As shown in the cut away, a membrane 1-13 is clamped between the base plate 1-11 and the base ring 1-15. In alternate embodiments of the invention, a mechanism which responds to pressure like the membrane probe described, viz., by moving sideways by about 20 microns to effect a scrubbing action on the test pads in contact, could be used instead of the membrane 1-13. In the preferred embodiment of the invention, the membrane 1-13 is a test probe membrane as discussed EP 0230348 mentioned above. A protective layer 1-17 resides between the base ring 1-15 and the base plate 1-11. This protective layer 1-17 protects the membrane 1-13 while exposing the test equipment contacts 1-21 which form interface ports receiving test signals for the probe. The membrane 1-13 engages with the travelling device 1-3 through an insulator 1-23. The insulator 1-23 is constructed from plastic such as 'lexan' (TM) and protects the delicate membrane 1-13 from abrading with the travelling means 1-3. More importantly, the insulator 1-23, 3-23 deflects the membrane 1-13, 3-13 away from the base 1-5, 3-5 as shown in Figure 3.

In the apparatus according to the preferred embodiment of the invention, the travelling device 1-3, 2-3 is a metal pentagonal plate .31 cm thick. The travelling device 1-3, 2-3 has a large hole for visually aligning the membrane 1-13 with the wafer under test. In the preferred embodiment of the invention, the constant length spring device 1-7, 2-7 is a leaf spring connected between the travelling device 1-3 and the base ring 1-15. In alternate embodiments of the invention, the constant length pivot device 1-7 can have numerous embodiments such as rod, bar, or other stiff member connected between the travelling device 1-3 and the base ring 1-15 through pivot joints which allow the rod, bar, or other stiff member to rotate.

In the preferred embodiment of the invention, the variable length spring 1-9 has a expansion device 1-25 and a leaf spring 1-31 that is connected between the base ring 1-15 and the expansion device 1-25. The leaf spring 1-31 is very similar to the constant length pivotal device 1-7. Likewise, the leaf spring 1-31 can be replaced by a rod, bar, or other stiff member connected between base ring 1-15 and the expansion device 1-25 through a pivot joint. In the preferred embodiment of the invention, the expansion device 1-25 is an integral part of the traveling device 1-3. In alternate embodiments of the invention, the expansion device 1-25 may be a separate component. The expansion device 1-25 lengthens in the direction of the traveling device's 1-3 sideways motion. In the preferred embodiment, each variable length spring has one expansion device 1-25. Each expansion device 1-25 has two H-shaped holes 1-27 and one elongated hole 1-29. In operation, the constant length pivotal device 1-7 pulls the traveling device 1-3 towards itself. The H-shaped holes 1-27 are weak in this direction and expand under the pulling force. Additionally, the two elongated holes 1-29 are weak in the direction of the traveling device's 1-3 motion. When the H-shaped holes 1-27 and the elongate holes 1-29 expand in the direction of the constant length pivot device 1-7, the traveling device 1-3 and the attached membrane I-14 move sideways.

The spring rate of the variable length spring 1-9 depends primarily on three major factors. The stiffness of the web which is determined by the web thickness 2-33; the distance across the two H-shaped holes 1-27; and the dimensions of the constant length spring 1-7. In the preferred embodiment of the invention, the web thickness is .38 cm throughout the variable length spring 1-9. The distance across the H-shaped holes 1-27 is . And the constant length pivotal device has a length equal to .95 cm width equal to.63 cm and a thickness equal to .03 cm. The resulting variable length spring 1-9 has spring rate of 2500 lb/in. With a spring rate of 2500 lb/in, the constant length pivot device 1-7 must pull on the variable length spring device with a force of 2 lb to make the variable length spring device move sideways 20 microns. The H-shaped hole 1-27 reduces the spring rate and thereby reduces the force the constant length pivot device 1-7 must exert in order to produce a sideways motion of 20 microns. This has the advantage of reducing the force between the wafer and the test probe.

The apparatus, according to the preferred embodiment of the invention, is designed so that the traveling device 1-3 does not tilt. There are several features of the traveling device 1-3 and the expansion device 1-25 that prevent the tilting. The traveling device 1-25 is thick, .31 inch, so that it does not bend. Additionally, the H-shaped holes 1-27 and the elongated holes 1-29 are designed to be weak in the sideways direction of travel but strong in every other direction. The H-shaped holes 1-27 can be viewed as rectangular hole with metal extensions into the holes which make the traveling device, in the vicinity of the hole, resistent to bending or tilting. Alternate embodiments of the invention may have a expansion device with holes having a different shape without departing from the scope of the invention. Additionally, tilting of the

travelling device 1-3 may be acceptable or even desirable in some applications. The resulting alternate embodiments may allow tilting without departing from the scope of the present invention. In other alternate embodiments, the expansion device 1-25 may have an accordian or other structure that expand when placed under tension. Such an embodiment does not depart from the scope of the present invention.

An alternate embodiment of the invention uses the variable length spring shown in Figure 4. A flexture pivot 4-37 moves out of the confinement slot 4-35 as the travelling device 4-39 is pushed away from the base 4-41. The confinement slot 4-35 confines the motion of the flexture pivot 4-37 to the horizontal plane and only allows the flexture pivot 4-37 to apply verticle forces to the travelling device 4-39. This embodiment has the advantage that no sideways forces or torques are applied to the travelling device 4-39 or the flexture pivot 4-37.

An apparatus according to the preferred embodiment of the invention is used as follows: The test wafer is pushed against the probe card at its contact area (1-13, 2-13). Specifically, the wafer is held on a chuck; it is then stepped and position directly under the probe card (1-3), which is held in a fixed position by a "prober" harness. Once the wafer is in position, that is aligned to the contacts on the probe card, the chuck is activated to push the wafer against the probe card contacts. As the probe card makes contact with the wafer, its contact pads (12-13) are pushed and forced to move sideways by about 20 microns to slightly abrade the surface of the test wafer contact pads. This action results in clean metal on the contacts for making good electrical contact.

Pushing a wafer against the test probe membrane 1-13 causes the travelling means 1-3 to lift out of the resting position shown in Figure 1. When the wafer pushes the travelling device 1-3 out of its resting position, the constant length pivot device 1-7 rotates upwards and thereby exerts a force on the traveling device 1-3 which tends to pull it towards the constant length pivot device 1-7. The leaf springs 1-31 of the variable length spring device 1-9 also rotates upwards. In response to forces exerted by the constant length pivotal device 1-7, the expansion device 1-25 lengthens to allow the traveling device 1-3 and the attached membrane 1-13 to move sideways toward said constant length pivot device 1-7. The expansion device 1-25 lengthens by the expansion of the H-shaped hole 1-27 and the elongated hole 1-29 in the direction of the constant length pivot device 1-7.

The apparatus according to the preferred embodiment of the present invention is manufactured by drilling the elongated holes 1-29 and the H-shaped holes 1-27 into a plate of metal .31 cm thick. The drill has a diameter of .16 cm

Three leaf springs 1-7 and 1-31 of equal length are mounted between the base 1-5 and the traveling device 1-3. The leaf springs are located 120 degrees apart so that they will act symmetrically. Two leaf springs are located adjacent to the extension device 1-25. The membrane 1-13 is glued to an insulator ring 1-23 which is mounted on the traveling device 1-3. A solid spring is placed on top of the traveling device 1-3. In the preferred embodiment of the invention, an apparatus for aligning the membrane 1-13 with the wafer under test is attached to the apparatus 1-2. The apparatus for aligning is similar to that described in U.S. Patent Application entitled Apparatus and Method for Aligning Two Surfaces filed on 1.30/87. The inventor Farid Matta and the assignee is the Hewlett-Packard Company. Hewlett-Packard docket number for this patent application is 186356. This patent application is incorporated herein by reference.

Claims

1. An apparatus comprising: a base means (1-5); a travelling means (1-3); a variable length spring means (1-9) attached to said travelling means (1-3) and said base means (1-5); a constant length pivot means (1-7) attached to said travelling means (1-3) and said base means (1-5); and wherein the movement of said travelling means (1-3) away from said base means (1-5) forces said constant length pivot means (1-7) to rotate about said base means (1-5), which forces said variable length spring means (1-9) to expand and thereby permits said travelling means (1-3) to move sideways as it moves away from said base means (1-5).

2. An apparatus as claimed in claim 1, for scrubbing the contact pads of a semiconductor wafer, comprising: a test probe means (1-13) attached to said travelling means (1-3) mounted so that said test probe (1-13) scrubs said contact pads of said wafer when the travelling means (1-3) moves sideways.

3. An apparatus as in claim 1 or 2 wherein said variable length spring means (1-9) and said constant length pivot means (1-7) are attached to different halves of said travelling means (1-3).

4. An apparatus as in claim 1,2 or 3 wherein said constant length pivot means (1-7) is a leaf spring attached between said base means (1-5) and said travelling means (1-3).

5. An apparatus as in any preceding claim wherein said constant length pivot means (1-7) comprises: a first pivot attached to said travelling

means a second pivot attached to said base means; and a rod attached to first pivot and said second pivot.

6. An apparatus as in any preceding claim wherein said variable length spring means (1-9) further comprises: a means for expanding (1-25) in said sideways direction a second constant length pivot means (1-31) attached to said means for expanding (1-25) in said sideways direction; and wherein said rotation of said constant length spring means (1-3) causes said means for expanding (1-25) to expand sideways which forces said travelling means (1-3) to move sideways.

7. An apparatus as in claim 6 wherein said means for expanding (1-25) is attached to said travelling means (1-3); and said second constant length pivot means (1-31) is a leaf spring attached to said means for expanding (1-25) and said base means (1-5).

8. An apparatus as in claim 6 or 7 wherein said means for expanding (1-24) in said sideways direction is in integral part of said travelling means (1-3).

9. An apparatus as in claim 6,7 or 8 wherein said means for expansion (1-25) comprises: an elongated hole (1-29) with the elongated axis perpendicular to the direction of said sideways motion: and two H-shaped holes (1-27) placed adjacent to said elongated hole (1-29).

10. An apparatus as in any preceding claim wherein said variable length spring means (1-9) further comprises: a flexture pivot (4-37) fastened to said base means (4-41); and a confinement slot (4-35) located on said travelling means (4-39) that permits said flexture pivot (4-37) to move in and out of said confinement slot (4-37).

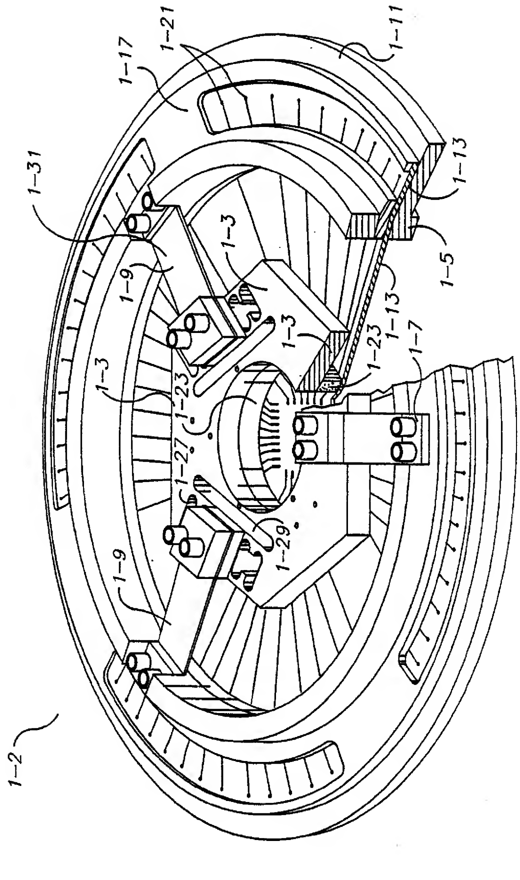

FIG 1

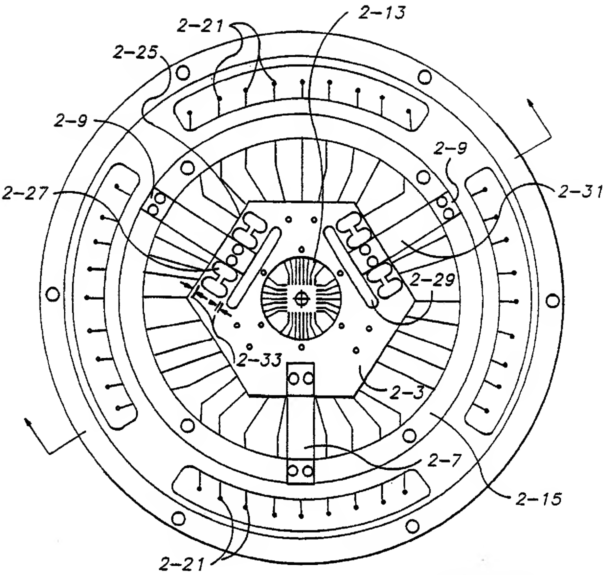
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FIG 2

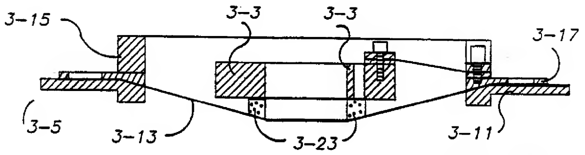
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FIG 3

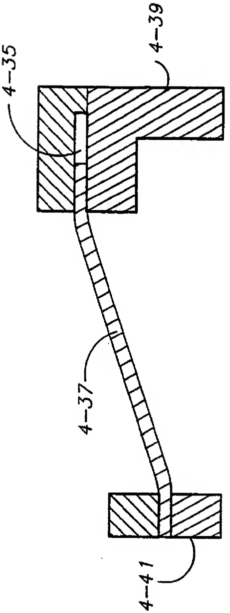

FIG 4

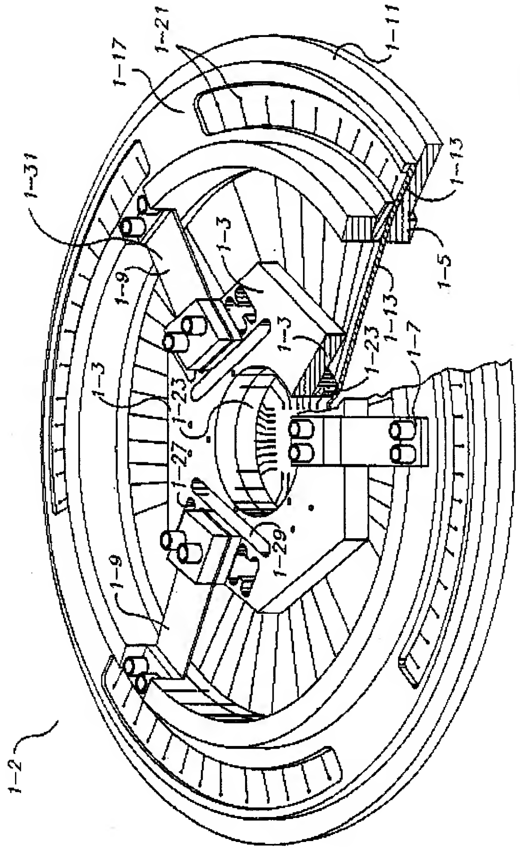

FIG 1

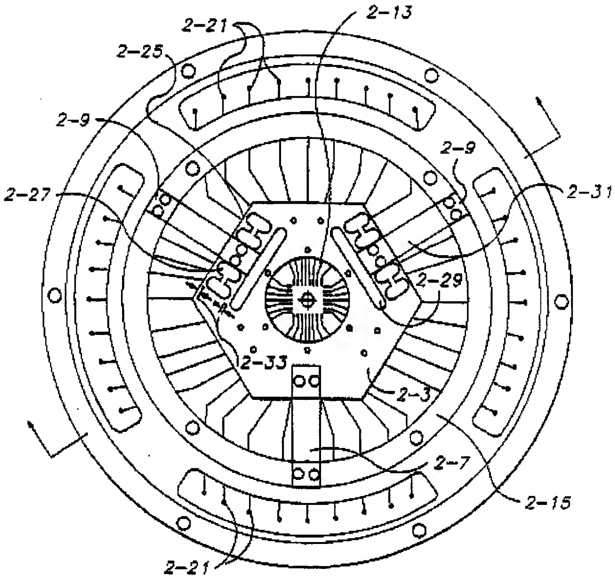
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FIG 2

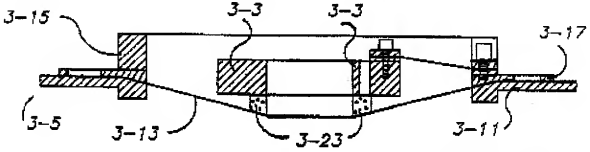
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FIG 3

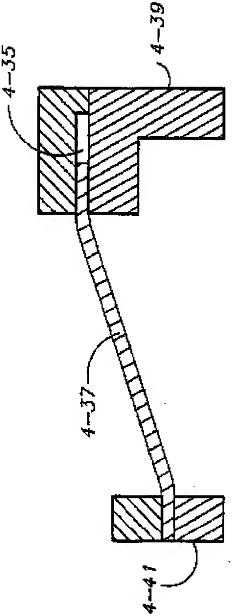

FIG 4

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(12) # EUROPEAN PATENT APPLICATION

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(54) **Method and apparatus for automatically scrubbing a surface.**

(57) The apparatus disclosed removes oxide from the contact pads of the wafer under test. The apparatus has a test probe membrane (1-13) attached to a traveling device (1-3). The traveling device (1-3) attaches to a base (1-5) through one or more constant length pivoting devices (1-7) and one or more variable length springs (1-9). When a wafer pushes against the test probe membrane (1-13), the traveling device (1-3) moves upwards. The constant length pivotal device (1-7) and the variable length springs (1-9) control the sideways motion of the traveling device (1-3). When the traveling device (1-3) lifts from its resting position, it moves sideways and thereby allows the test probe membrane (1-13) to scrub the contact pads of the wafer under test.

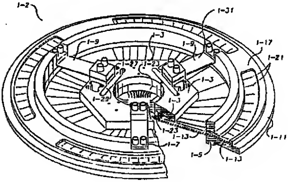

FIG 1

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 30 2142

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-4 103 232 (K. SUGITA et al.) * Column 9, lines 16-31; figures 19A, 19B * ---	1,3,4	G 01 R 1/073 G 01 R 31/28
A	DE-B-2 613 858 (SIEMENS AG) * Claims 1-3; figures * ---	2	
A	US-A-3 702 439 (B.H. McGAHEY) * Column 5, line 55 - column 6, line 63; figures 2,3 * ---	2	
A	IBM TECHNICAL DISCLOSURE BULLETIN, vol. 16, no. 12, May 1974, pages 4087-4088, New York, US; C.T. McNUTT: "Test carrier for "leadless" hybrid diode matrix modules" * Whole article * -----	2	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			G 01 R H 05 K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20-06-1988	PENZKOFER, B.

CATEGORY OF CITED DOCUMENTS

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